Marking Scheme:

Question No.		Difficulty level	Cognitive levels	Marking Scheme
Q.1)	a)	M	Application	i)Types of salts – 2 marks ii)carbonate alkalinity = 80 ppm , bicarbonate alkalinity = 120 ppm-4 marks
	b)	M	Comprehension	2 principles – 2 marks, 4 points of comparison – 4 marks
	c)	M	Comprehension	Definition – 1 mark, figure – 2 marks, principle – 1 mark
Q.2)	a)	M	Application	i)Definition -1 mark, types – 2marks ii)Total hardness – 1400 ppm-1 mark, Permanent hardness 728 ppm– 1 mark, Temporary hardness 672ppm– 1 mark (Total-3 marks)
	b)	M	Application	i)Zeolite – 1 mark, principle with reactions – 2 marks ii)Hardness of water = 244.2 ppm – 3marks
	c)	M	Comprehension	4 points – 4marks
Q.3)	a)	M	Comprehension	Cell reactions – 1 mark, procedure – 1 mark,calculations – 3 marks, titration curve – 1 mark
	b)	M	Comprehension	Definition – 1 mark each Explanation with example – 1 mark each
	c)	L	Comprehension	Definition – 1 mark, diagram – 1 mark, representation – 1 mark, two advantages – 1 mark
Q.4)	a)	M	Comprehension	Possible transitions – 1 mark, figure – 1 mark, 4 transitions with example -4 marks
	b)	M	Application	i)E = 0.75V – 2 marks ii)E = 1.1V – 2 marks
	c)	M	Comprehension	Definition – 1 mark, titration curve – 1 mark, explanation – 2 marks

Numericals solution:

Q.1) ii) Volume for phenolphthalein end point $= V_1 = 4$ ml

Volume for methyl orange end point $= V_2 = 4 + 16 = 20$ ml

Volume of water $= V = 100$ ml, $Z = \frac{1}{50}$ N.

∴ Phenolphthalein alkalinity $= P = \frac{V_1}{V} \times Z \times 50 \times 1000$ ppm

∴ $= \frac{4}{100} \times \frac{1}{50} \times 50 \times 1000$

$= 40$ ppm

∴ methyl orange alkalinity $= M = \frac{V_2}{V} \times Z \times 50 \times 1000$

$= \frac{20}{100} \times \frac{1}{50} \times 50 \times 1000$

$= 200$ ppm

Relation betⁿ P & M =

As $P < \frac{1}{2} M$ ∴ water contains CO_3^{-2} & HCO_3^{-2}

CO_3^{-2} alkalinity $= 2P = 2 \times 40 = 80$ ppm

HCO_3^- alkalinity $= M - 2P = 200 - (80) = 120$ ppm.

Q.2) a) Given, molarity of EDTA $= Z = 0.02$ M

$y = 17.5$ ml

$V = 25$ ml

∴ Total hardness $= \frac{y}{V} \times Z \times 100 \times 1000$ ppm

$= \frac{17.5}{25} \times 0.02 \times 100 \times 1000$

$= 1400$ ppm.

After boiling, temporary hardness gets removed and boiled water contains only permanent hardness.

For boiled water titration,

$x = 9.1$, $Z = 0.02$, $V = 25$ ml

∴ Permanent hardness $= \frac{x}{V} \times Z \times 100 \times 1000$

$= \frac{9.1}{25} \times 0.02 \times 100 \times 1000$

$= 728$ ppm

Temporary hardness = 1400 − 728

= 672 ppm.

Q.4) b) i) By $N_1V_1 = N_2V_2$, volume at equivalence point is 100 ml.

When 50 ml of 0.1 N Ce^{+4} is added, that is before equivalence point

$$\therefore E = E_1^\circ + \frac{0.0591}{1} \log \frac{[Fe^{+3}]}{[Fe^{+2}]}$$

$E_1^\circ = 0.75$, $[Fe^{+3}] = 50 \times 0.1 = 5$ m mole

$[Fe^{+2}] = (100 \times 0.1) - (50 \times 0.1)$

= 5 m mole

$$= 0.75 + 0.0591 \log \frac{5}{5}$$

$= 0.75$ V.

ii) 100 ml of 0.1 N Ce^{+4} added, is at equivalence point.

$$\therefore E = \frac{E_1^\circ + E_2^\circ}{2} = \frac{0.75 + 1.45}{2} = 1.1 \text{ V}.$$

Q.2) b). (i) Quantity of NaCl =

100 ml soln. contain 10 gm NaCl

∴ 1000 ml (1 lit.) soln. contain 100 gm NaCl

∴ 10 lit. of soln. contain ≡ 1000 gm NaCl

(ii) Cal^n of $CaCO_3$ equivalent.

1 mM NaCl ≡ $\frac{1}{2}$ m $CaCO_3$

58.5 gm ≡ 50 gm

∴ 1000 gm ≡ ? = 854.7 gm

(iii) Cal^n of hardness –

3500 lit. water ≡ 854.7 gm $CaCO_3$ eq.

∴ 1 lit water ≡ ? = 0.2442 gm

= 244.2 mg/lit

or ppm